INDOOR AIR QUALITY ASSESSMENT

Glover School
255 Canton Avenue
Milton, MA 02186

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Emergency Response/Indoor Air Quality Program
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Background/Introduction

At the request of the Milton Health Department (MHD), the Massachusetts Department of Public Health's (MDPH), Center for Environmental Health (CEH) provided assistance and consultation regarding indoor air quality at the Glover School (GS), 255 Canton Avenue, Milton, Massachusetts. The request was prompted by odor complaints related to the kitchen/cafeteria area.

On February 2, 2005, a visit to conduct an indoor air quality assessment at the GS was made by Sharon Lee, an Environmental Analyst in CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program. During the assessment, MDPH staff were accompanied by Nelly Browne-Janga (MHD) and for portions of the assessment, Bill Ritchie, Director of Facilities/Operations, Milton Public Schools (MPS).

The GS is a single-story building constructed in 1957 and located near a brook. In 2004, a number of additions and renovations to the building were completed. The GS consists of a gymnasium, general classrooms, computer room, library, administrative offices, kitchen and cafeteria. Windows throughout the school are openable.

As previously mentioned, the purpose of the visit was in response to odor complaints reportedly related to the kitchen/cafeteria. According to school officials, cafeteria workers noted persistent sewer gas odors in the cafeteria's kitchen area during the fall of 2004. The cafeteria manager experienced a number of symptoms, including nausea and vomiting. In response the school department contacted their utility company and they determined that a leak existed in the gas lines. The lines were subsequently repaired, however the odor remained. Further investigation by school department officials determined that grease traps in the kitchen had not been cleaned for some time. In response a maintenance protocol to ensure traps are cleaned routinely was developed. The protocol also calls for water to be poured down all sink and floor drains to maintain the integrity of the traps. Finally, ventilation pipes were raised to prevent odor entrainment from the brook and surrounding areas. Unfortunately, despite these collective efforts, odors persisted.

In October 2004, school officials contracted with Diversified Environment Corporation (DEC) for testing of various volatile organic compounds (VOCs) and airborne dust. According to DEC's report, VOC levels were non-detect (ND) or extremely low and airborne dust levels were also extremely low (DEC, 2004). Although the DEC report showed VOC levels were either ND or low, cafeteria workers still reported odors. On or about January 2005, Mr. Ritchie examined pipes in the crawlspace below the cafeteria kitchen. He discovered that some pipes had been severed. Following this discovery, the pipes were sealed. Mr. Ritchie reported that some residue and odors from the pipes remained in the crawlspace. Following school department efforts and the DEC investigation MDPH was asked for assistance.

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were conducted with the TSI, Q-TRAK™ IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID).

Results

The school currently houses approximately 560 kindergarten through fifth grade students, as well as a staff of approximately 50. Tests were taken during normal operations at the school, and results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million (ppm) in nine of forty-six areas surveyed, indicating adequate ventilation in most areas. Mechanical ventilation is provided by rooftop air-handling units (AHUs) (Picture 1). Fresh air is distributed via ceiling-mounted air diffusers and ducted back to AHUs via ceiling-mounted return vents (Pictures 2 and 3). It is important to note that the location of some exhaust vents can limit exhaust efficiency. In several classrooms, exhaust vents are located above hallway doors (Picture 4). When classroom doors are open, exhaust vents will tend to draw air from both the hallway and the classroom reducing the effectiveness of the exhaust vent to remove common environmental pollutants.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The system should have been balanced over the summer of 2004, following renovations and prior to occupation.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, consult Appendix A.

Temperature measurements ranged from 68° F to 75° F, which were within or very close to the MDPH recommended comfort range. The MDPH recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. Temperature control complaints were expressed to MDPH staff in a few areas. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 15 to 21 percent, which was below the MDPH recommended comfort range. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture

Plants were observed in several classrooms and, in some cases, on paper materials (Picture 5). Plants, soil and drip pans can serve as sources of mold growth. Plants should be properly maintained, over-watering of plants should be avoided and drip pans should be inspected periodically for mold growth. Plants should also be located away from ventilation sources to prevent aerosolization of dirt, pollen or mold.

A number of areas had water-stained ceiling tiles, which can indicate leaks from the roof or plumbing system (Picture 6). Stains were also noted on gypsum wallboard (Picture 6). Water-damaged porous building materials can provide a source for mold and should be repaired/replaced after a water leak is discovered and repaired.

Lastly, spaces between the sink countertop and backsplash were seen in several areas (Picture 7). Improper drainage or sink overflow can lead to water penetration into the countertop, cabinet interior and areas behind cabinets. If these materials become wet repeatedly they can provide a medium for mold growth.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur.

Other Concerns

Indoor air quality can be adversely impacted by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion products include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the school environment, MDPH staff obtained measurements for carbon monoxide and PM2.5.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide pollution and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

ASHRAE has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000a). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS established by the US EPA, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000a).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Outdoor carbon monoxide concentrations were non-detect or ND (Table 1). Carbon monoxide levels measured in the school were also ND.

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits for particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 micrograms per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2000a). This standard was adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA

Code, US EPA proposed a more protective standard for fine airborne particles. This more stringent, PM2.5 standard requires outdoor air particulate levels be maintained below 65 $\mu g/m^3$ over a 24-hour average (US EPA, 2000a). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective proposed PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations were measured at 41 $\mu g/m^3$ (Table 1). PM2.5 levels measured indoors ranged from 9 to 37 $\mu g/m^3$. Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

Indoor air quality can also be impacted by the presence of materials containing volatile organic compounds (VOCs). VOCs are substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted. Outdoor air samples were taken for comparison. Outdoor TVOC concentrations were ND (Table 1). Indoor TVOC measurements throughout the building were also ND in all but one area. Classroom 30 had a TVOC measurement of 1.9 ppm, where MDPH staff detected dry erase marker odors.

Please note, TVOC air measurements are only reflective of the indoor air concentrations present at the time of sampling. As illustrated by the TVOC measurement, in classroom 30, indoor air concentrations can be impacted by the use of TVOC containing products. While TVOC levels were ND in most classrooms, the use of VOC-containing materials was noted. A number of classrooms contained dry erase boards and dry erase markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, (e.g. methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Cleaning products were also found on countertops and in unlocked cabinets beneath sinks in some classrooms (Picture 8). Like dry erase materials, cleaning products contain VOCs and other chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. Several areas contain photocopiers and lamination machines. VOCs and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, 1992). Lamination machines can produce irritating odors during use. These areas are equipped with local exhaust ventilation; occupants should ensure that vents are operating to help reduce excess heat and odors.

As previously discussed, the purpose of this assessment was to investigate an odor in the cafeteria's kitchen area. According to school officials, appropriate measures were taken to seal open pipes in the crawlspace area. At the time of assessment, MPDH staff did not detect odors and were unable to access the crawlspace. However, MDPH staff observed spaces around pipes in the floor of the kitchen area and recommended sealing to prevent movement of odors from the crawlspace into the kitchen. A slight negative pressure should also be maintained in the crawlspace to ensure that crawlspace-related odors remain in the crawlspace and are not pressurized into occupied areas. MPS staff should also ensure that local ventilation to the cafeteria's kitchen area be operated at all times, regardless of occupancy.

Several other conditions that can affect indoor air quality were noted during the assessment. In some classrooms, items were observed on windowsills, tabletops, counters, bookcases and desks or piled into the corner of rooms (Picture 9). The large number of items stored in classrooms provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up. To prevent dust accumulation, flat surfaces should be wet-wiped and vacuumed periodically with a vacuum equipped with a high efficiency particle arrestance (HEPA) filter.

A number of exhaust/return vents in classrooms and restrooms had accumulated dust. If exhaust vents are not functioning, backdrafting can occur, which can re-aerosolize dust particles. Similarly, covers to exhausts vents that had been deactivated were loose or not intact in many rooms (Picture 10). This can result in dust accumulation in their ducts that can be re-aerosolized due to backdrafting. Fan blades to personal fans were also noted with accumulated dust (Picture 11). When these fans are activated, dust can become aerosolized. As discussed, dust can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation. Dust can be irritating to eyes, nose and respiratory tract.

In an effort to reduce noise from sliding chairs, tennis balls had been sliced open and placed on chair legs (Picture 12). Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and cause TVOCs to off-gas. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as Appendix B (NIOSH, 1998). Consider replacing tennis balls with alternative glides (Picture 13).

Improperly stored food and re-use of food containers were noted (Picture 8). Proper food storage is an integral component in maintaining indoor air quality. Food should be properly stored and clearly labeled. Reuse of food containers is not recommended since food residue adhering to the surface may serve to attract pests. School officials stated that an IPM plan was in place and that baited traps were used in several areas. To prevent pest infestation, pathways for ingress and attractants (i.e., food) should be reduced/eliminated.

Lastly, birds were observed near an exhaust tower (Picture 14). To prevent bird roosting within the tower, consider installing bird netting around the louvers of the tower to prevent entry. Birds can be a source of disease, and bird wastes and feathers can contain mold, which can be irritating to the respiratory system.

Conclusions/Recommendations

At the time of the MDPH assessment, odors were not detectable in the kitchen area and measures had been taken to prevent odor infiltration from the crawlspace. MDPH did recommend additional measures that should result in further reduction/elimination of odors.

In view of the findings at the time of the visit, the following recommendations are made to improve general indoor air quality:

1. Continue to monitor the cafeteria area for odors.
2. Ensure spaces around pipes and breaks in the floor are sealed to prevent migration of odors from the crawlspace to occupied areas.
3. Use local exhaust ventilation and isolation techniques (e.g. sealing breaches) to prevent odors.
4. Operate both supply and exhaust ventilation continuously, independent of classroom thermostat control, during periods of school occupancy to maximize air exchange.
5. Consider having the ventilation system balanced by an HVAC engineer every five years (SMACNA, 1994).
6. Ensure classroom doors in some areas are closed during periods of school occupancy to maximize exhaust ventilation.
7. Encourage faculty and staff to report concerns regarding temperature control/preventive maintenance issues to the facilities department via the main office or alternate reporting procedure. Consider developing a written notification system for building occupants to report indoor air quality issues/problems, if one is not already in place (Appendix C).
8. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during

the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

9. Ensure all plants are equipped with drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary.
10. Store cleaning products properly and out of reach of students.
11. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
12. Replace coverings to deactivated exhaust vents to prevent aerosolization of dust through backdrafts.
13. Clean accumulated dust from exhaust vents and blades of personal fans.
14. Discontinue the use of tennis balls on chairs to prevent latex dust generation. Alternative "glides" can commonly be purchased from office supply stores.
15. Install netting/screening around exhaust tower to prevent bird roosting.
16. Ensure local exhaust ventilation is activated in areas with photocopiers and lamination machines, or relocate to a well-ventilated area.
17. Consider adopting the US EPA (2000b) document, *Tools for Schools*, in order to provide a self assessment and maintain a good indoor air quality environment at your building. The document is available from the Internet: http://www.epa.gov/iaq/schools/index.html.
18. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. These documents are located on the MDPH's website: http://www.state.ma.us/dph/MDPH/iaq/iaqhome.htm.

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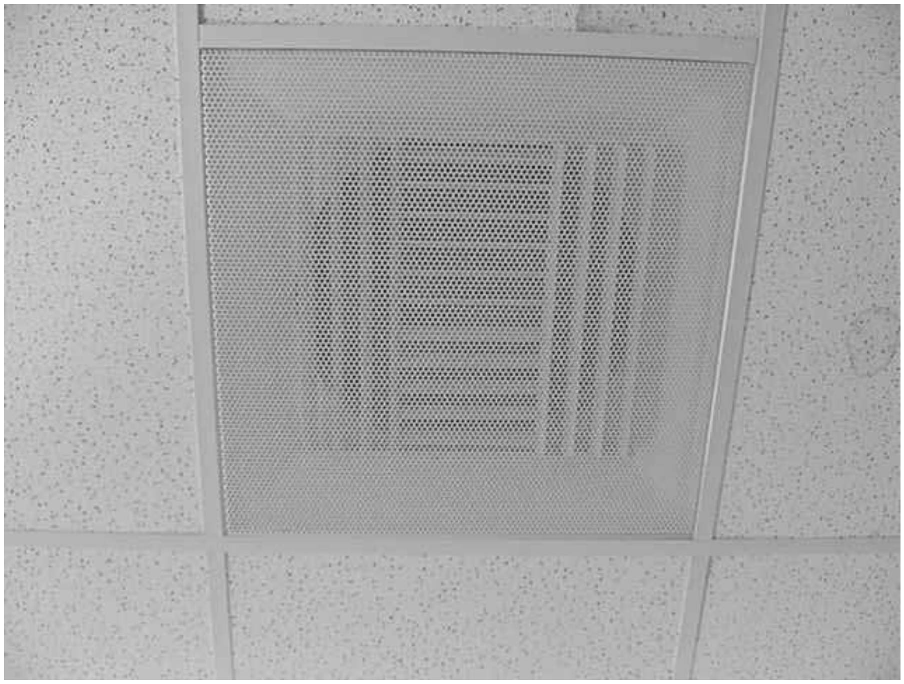
Picture 1

Rooftop air-handling unit

Picture 2



Ceiling ducted supply

Picture 3

Ceiling ducted exhaust

Picture 4

Exhaust near classroom door to hallway

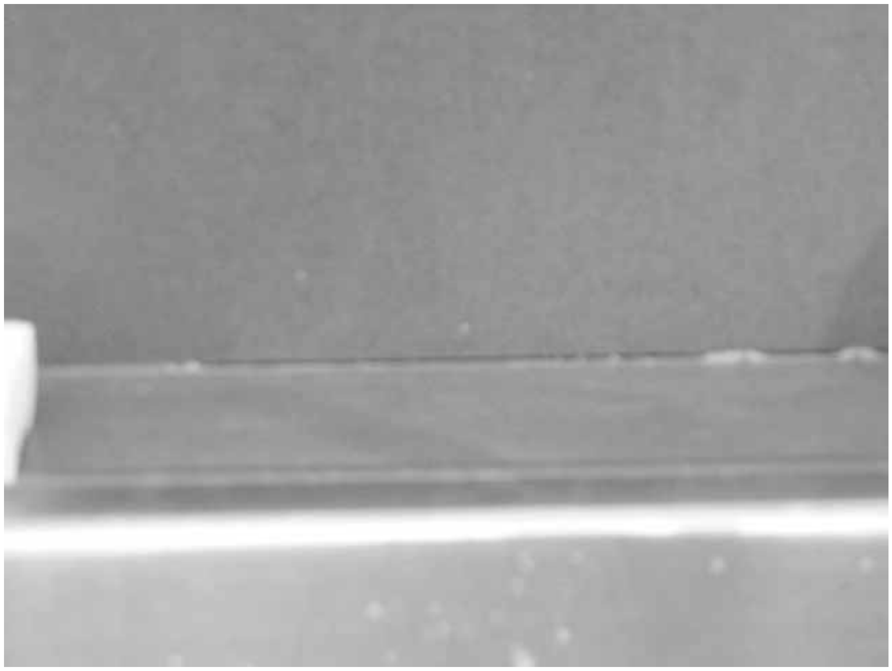
Picture 5

Plant on paper material

Picture 6

Water damaged ceiling tile and gypsum wallboard

Picture 7



breach between sink countertop and backsplash

Picture 8

Cleaners on sink countertop

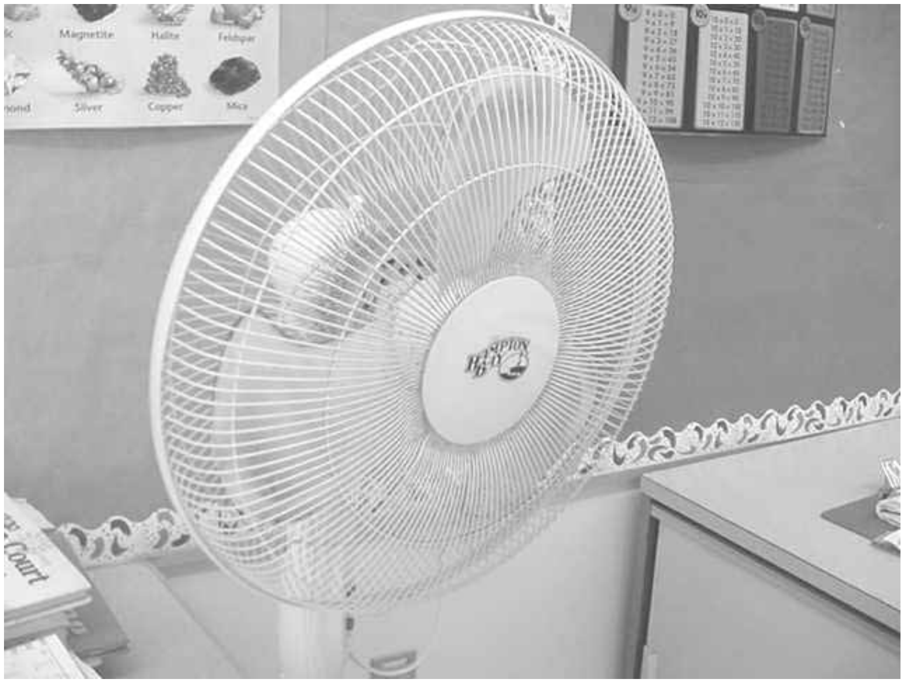
Picture 9

Items stored in corner of classroom

Picture 10

Missing cover to deactivated exhaust

Picture 11

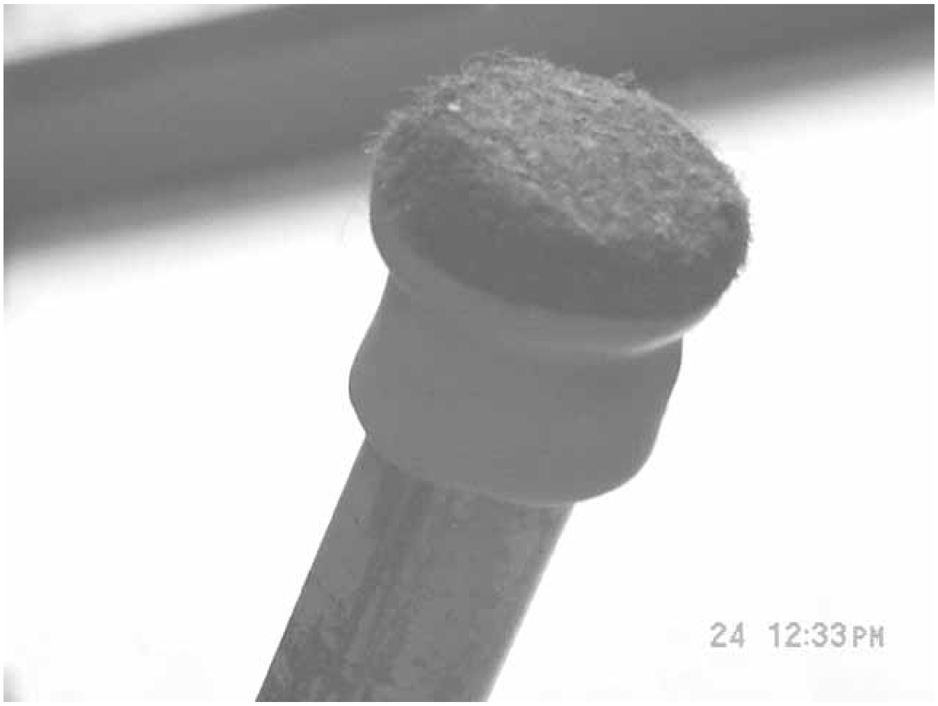


Dust occluding fan blades

Picture 12

Tennis balls on chair legs

Picture 13



“Glides” for Chair Legs That can be Used as an Alternative to Tennis Balls

Picture 14

Birds near exhaust tower

Glover Elementary School **Indoor Air Results**

255 Canton Ave, Milton, MA **February 2, 2005**

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
background	ND	43	27	381	ND	ND	41				Comments: sunny, light wind.
cafeteria kitchen	4	72	16	606	ND	ND	22	Y # open: 0 # total: 0	Y ceiling	Y ceiling wall	Inter-room DO, #MT/AT : 1.
cafeteria office	ND	71	17	729	ND	ND	21	N			Clothing dryer.
cafeteria	4	72	16	589	ND	ND	19	N	Y ceiling	Y wall	
teacher's planning/music	2	72	19	919	ND	ND	16	Y # open: 0 # total: 2	Y ceiling	Y ceiling	Inter-room DO, laminator.
copy room	6	73	20	1076	ND	ND	18	Y # open: 0 # total: 2	Y ceiling	Y ceiling	Hallway DO, PC.
nurse	5	72	20	973	ND	ND	19	Y # open: 0 # total: 2	Y ceiling	Y ceiling	Hallway DO, Inter-room DO, breach sink/counter.

ppm = parts per million
µg/m3 = micrograms per cubic meter

AD = air deodorizer
AP = air purifier
aqua. = aquarium
AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials
design = proximity to door
FC = food container
G = gravity
GW = gypsum wallboard
M = mechanical
MT = missing ceiling tile
NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings
sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
WD = water damage
WP = wall plaster

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Glover Elementary School
255 Canton Ave, Milton, MA

Indoor Air Results
February 2, 2005

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
curriculum coordinator	1	71	16	525	ND	ND	15	Y # open: 0 # total: 6	Y ceiling	Y ceiling	DEM, plants.
gym	7	71	20	645	ND	ND	15	N	Y ceiling	Y ceiling	Hallway DO,
library	23	72	19	711	ND	ND	13	N	Y ceiling	Y ceiling	
administration office	4	72	21	786	ND	ND	10	Y # open: 0 # total: 3	Y ceiling	Y ceiling	Inter-room DO,
Assistant Principal's Office	ND	73	19	743	ND	ND	9	N	Y ceiling	Y ceiling	Inter-room DO,
Principal's Office	ND	71	21	667	ND	ND	9	Y # open: 0 # total: 2	Y ceiling	Y ceiling	
1	ND	71	15	598	ND	ND	17	Y # open: 0 # total: 7	Y ceiling	Y ceiling	DEM, cleaners, items, Comments: lose exhaust cover.

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Comfort Guidelines

Carbon Dioxide:	< 600 ppm = preferred	Temperature:	70 - 78 °F
	600 - 800 ppm = acceptable	Relative Humidity:	40 - 60%
	> 800 ppm = indicative of ventilation problems		

Glover Elementary School | **Indoor Air Results**

255 Canton Ave, Milton, MA | **February 2, 2005**

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									Supply	Exhaust	
2	9	72	19	1097	ND	ND	18	Y # open: 0 # total: 7	Y ceiling	Y ceiling	breach sink/counter, DEM.
3	18	68	19	730	ND	ND	37	Y # open: 0 # total: 0	Y ceiling	Y ceiling	#WD-CT: 3, breach sink/counter, DEM, temperature complaints (cold), temperature complaints (hot).
4	23	69	21	1251	ND	ND	25	Y # open: 0 # total: 7	Y ceiling	Y ceiling	#WD-CT : 1, DEM.
5	ND	73	16	696	ND	ND	18	Y # open: 4 # total: 7	Y ceiling	Y ceiling	Hallway DO, breach sink/counter, DEM.
6	21	75	21	743	ND	ND	16	Y # open: 0 # total: 4	Y ceiling	Y ceiling	DEM, plants.
7	3	71	17	606	ND	ND	15	Y # open: 0 # total: 3	Y ceiling	Y ceiling	Hallway DO, DEM, items.

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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Glover Elementary School

255 Canton Ave, Milton, MA

Table 1

Indoor Air Results

February 2, 2005

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
8	ND	69	17	487	ND	ND	13	Y # open: 0 # total: 4	Y ceiling	Y ceiling	DEM, plants.
9	ND	70	16	527	ND	ND	14	Y # open: 0 # total: 3	Y ceiling	Y ceiling	Hallway DO,
10	ND	68	19	476	ND	ND	16	Y # open: 1 # total: 4	Y ceiling	Y ceiling	DEM.
11	17	70	18	824	ND	ND	14	Y # open: 0 # total: 4	Y ceiling	Y ceiling	DEM.
12 (art)	ND	70	18	640	ND	ND	15	Y # open: 0 # total: 10	Y ceiling	Y ceiling	Hallway DO, DEM, cleaners, items.
13	ND	69	17	528	ND	ND	13	Y # open: 0 # total: 6	Y ceiling	Y ceiling	Hallway DO, breach sink/counter, DEM, PF, items.

ppm = parts per million
µg/m3 = micrograms per cubic meter

AD = air deodorizer
AP = air purifier
aqua. = aquarium

AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
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design = proximity to door
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									Supply	Exhaust	
14	1	70	18	600	ND	ND	12	Y # open: 0 # total: 3	Y ceiling	Y ceiling	DEM.
15	20	70	19	7000	ND	ND	17	Y # open: 0 # total: 6	Y ceiling	Y ceiling	Hallway DO, Inter-room DO, DEM, PF, cleaners, items, Comments: plants on porous material.
16	ND	69	17	517	ND	ND	12	Y # open: 0 # total: 4	Y ceiling	Y ceiling	DEM.
17	20	70	19	700	ND	ND	17	Y # open: 0 # total: 6	Y ceiling	Y ceiling	Hallway DO, Inter-room DO, DEM, PF, PS, items, food use/storage, plants.
18	23	71	21	773	ND	ND	14	Y # open: 0 # total: 6	Y ceiling	Y ceiling	Hallway DO, DEM, items.
20	ND	71	18	470	ND	ND	12	Y # open: 0 # total: 5	Y ceiling	Y ceiling	Hallway DO, DEM.

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Glover Elementary School | **Indoor Air Results**

255 Canton Ave, Milton, MA | **February 2, 2005**

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									Supply	Exhaust	
21	15	70	19	635	ND	ND	13	Y # open: 0 # total: 6	Y ceiling	Y ceiling	Hallway DO, DEM, PF, TB, cleaners, items.
22	5	71	18	522	ND	ND	16	Y # open: 0 # total: 6	Y ceiling	Y ceiling	cleaners, items.
23	2	70	18	543	ND	ND	12	Y # open: 0 # total: 6	Y ceiling	Y ceiling	Hallway DO, DEM.
24	20	72	21	838	ND	ND	12	Y # open: 0 # total: 5	Y ceiling	Y ceiling location	Hallway DO, breach sink/counter, DEM, PF, plants.
25	19	70	20	724	ND	ND	14	Y # open: 0 # total: 6	Y ceiling	Y ceiling	Hallway DO, DEM, items.
27	ND	71	18	508	ND	ND	14	Y # open: 1 # total: 6	Y ceiling	Y ceiling	Hallway DO, DEM, plants.

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Glover Elementary School **Indoor Air Results**

255 Canton Ave, Milton, MA **Table 1** **February 2, 2005**

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									Supply	Exhaust	
28	8	72	20	884	ND	ND	10	Y # open: 0 # total: 5	Y ceiling	Y ceiling	food use/storage.
29	22	70	20	623	ND	ND	15	Y # open: 0 # total: 6	Y ceiling	Y ceiling	Hallway DO, DEM, cleaners, plants.
30	24	71	21	796	ND	1.9	17	Y # open: 0 # total: 5	Y ceiling	Y ceiling	Hallway DO, breach sink/counter, DEM, plants, Comments: DEM in use, DEM odors.
31	ND	70	17	503	ND	ND	11	Y # open: 0 # total: 6	Y ceiling	Y ceiling	Hallway DO, DEM.
32	20	72	19	768	ND	ND	16	Y # open: 0 # total: 4	Y ceiling	Y ceiling location	Hallway DO, breach sink/counter, DEM, PF, items.
33	ND	70	17	459	ND	ND	11	Y # open: 2 # total: 6	Y ceiling	Y ceiling	Hallway DO, breach sink/counter, DEM, plants.

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									Supply	Exhaust	
34	ND	71	17	466	ND	ND	12	Y # open: 0 # total: 5	Y ceiling	Y ceiling location	Hallway DO, DEM.
36	2	70	19	662	ND	ND	13	Y # open: 0 # total: 5	Y ceiling	Y ceiling location	Hallway DO, breach sink/counter, items.
37	60	73	19	1010	ND	ND	17	Y # open: 0 # total: 9	Y ceiling	Y ceiling	Breach sink/counter, DEM, Comments: dust complaint.

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